

**WHAT IS CLAIMED:**

1. A design template comprising:
  - 5 a torso section being one of a group comprising a large male, medium male and small female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture; and
  - 10 at least one cross-sectional section cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template used for designing, evaluating, and measuring human occupant accommodation and seating in a seated environment.
- 15 2. A design template as set forth in claim 1 wherein said torso section has a portion of an outer contour conforming to a deformed shape of an interface contour between a seat and a seated occupant.
- 20 3. A design template as set forth in claim 2 wherein said torso section includes anatomical details located relative to each other and the interface contour is located relative to said anatomical details.
- 25 4. A design template as set forth in claim 1 wherein said torso section includes indicia of skeletal

landmarks for a shoulder joint and a hip joint and an axis connected therebetween.

5        5.    A design template as set forth in claim 1  
      wherein said torso section includes a centerline projection of  
      a pelvis with indicia representing an ischial tuberosity,  
      anterior superior iliac spine, pubic symphysis and sacrum.

10       6.    A design template as set forth in claim 1  
      wherein said torso section includes an angular scale for torso  
      angle.

15       7.    A design template as set forth in claim 1  
      wherein said torso section includes an angular scale for hip  
      angle.

20       8.    A design template as set forth in claim 1  
      wherein said torso section has an anterior shape that is  
      anthropometrically and anatomically correct.

      9.    An occupant restraint system for a seat  
      comprising:

25        a lap belt being anchored to vehicle structure to  
      extend below an anterior superior iliac spine and above an  
      anterior inferior iliac spine for a design template with a  
      torso section being one of a group comprising an ERECT  
      posture, a NEUTRAL posture and a SLUMPED posture; and

a shoulder belt being anchored to vehicle structure to extend between a first predetermined distance from a centerline of the seat to a shoulder joint for a design template with a torso section being one of a group comprising  
5 a small female, a large male and a medium male and a second predetermined distance from the centerline of the seat to a neck/shoulder junction for the design template with the torso section being one of the group of the small female, medium male or the large male, said design template including at  
10 least one cross-sectional section cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template.

10. An occupant restraint system as set forth in  
15 claim 9 wherein said first predetermined distance is 190 mm for the small female, 246 mm for the medium male and 267 mm for the large male, and said second predetermined distance is 51 mm for the small female, 65 mm for the medium male and 71 mm for the large male.

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11. A method of establishing occupant accommodation criteria in a vehicle package based on a predetermined class of vehicles comprising:

providing a design template having a torso section  
25 being one of a group comprising a large male, medium male and small female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture and having a leg section and at least one cross-sectional section

cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template;

defining a planar region under an accelerator to provide a heel point for the leg section;

5 defining seat stiffness of a seat whether it is high stiffness (hard), low stiffness (soft) or some stiffness therebetween;

positioning the design template in the vehicle such that the eye line of sight is within vision requirements of  
10 the vehicle environment; and

positioning the design template in the vehicle such that the distance between the supplemental restraint system in the steering wheel to chest is as great as possible to provide a safe distance for each occupant driving the vehicle.  
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12. A method as set forth in claim 11 including the step of adjusting joint angles at an ankle, knee, and hip of the design template to lie within a predetermined range.

20 13. A method as set forth in claim 11 including the step of reclining the torso section a predetermined angle from vertical.

14. A method as set forth in claim 11 including the  
25 step of defining the seat design position at the rearmost and downmost position of the seat in the vehicle package.

15. A method for designing a seat comprising:

selecting at least one design template having a torso section being one of a group comprising a large male, medium male and small female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture and having a leg section and at least one cross-sectional section cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template;

forming load supporting contours of the occupied seat for the at least one design template; and

forming unloaded patches of the unoccupied seat for the at least one design template.

16. A method as set forth in claim 15 including the step of defining an offset surface contour of the design template in the occupied seat and seat structure.

17. A method as set forth in claim 15 including the step of estimating a first point of a shoulder patch on a seat back at a T4 spinal landmark.

18. A method as set forth in claim 15 including the step of estimating a first point of the load supporting patch of a seat back at S° under occupant load.

19. A method as set forth in claim 18 including the step of estimating a second point at  $S^U$  on the unloaded patch of the seat back.

5           20. A method as set forth in claim 15 including the step of estimating a first point of a load supporting patch of a seat back at  $L^0$  under occupant load.

21. A method as set forth in claim 20 including the  
10 step of estimating a second point at  $L^U$  on an unloaded patch of the seat back.

22. A method as set forth in claim 15 including the step of estimating a point on a bite line patch of a seat back  
15 at  $B''$ .

23. A method as set forth in claim 15 including the step of estimating a first point of a load supporting patch of a seat cushion at  $I_p^0$  under occupant load.

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24. A method as set forth in claim 23 including the step of estimating a second point at  $I_p^U$  on an unloaded patch of the seat cushion.

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25. A method as set forth in claim 15 including the step of estimating a first point of a load supporting patch of a seat cushion at  $T^0$  under occupant load.

26. A method as set forth in claim 25 including the step of estimating a second point at  $T^U$  on an unloaded patch of the seat cushion.

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27. A method as set forth in claim 26 including the step of optimally matching the unoccupied load support points for the other torso sections and postures of the design template to define the unoccupied seat patch.

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28. A method as set forth in claim 27 including the step of constructing an unloaded point  $S^U$  for each of the design templates.

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29. A method as set forth in claim 27 including the step of constructing an unloaded point  $L^U$  for each of the design templates.

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30. A method as set forth in claim 27 including the step of constructing an unloaded point  $I_p^U$  for each of the design templates.

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31. A method as set forth in claim 27 including the step of constructing an unloaded point  $T^U$  for each of the design templates.

32. A method as set forth in claim 15 including the step of defining an unoccupied seat patch for a shoulder region.

5           33. A method as set forth in claim 15 including the step of defining an unoccupied seat patch for a thorax region.

34. A method as set forth in claim 15 including the step of defining an unoccupied seat patch for a lumbar.

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35. A method as set forth in claim 15 including the step of defining an unoccupied seat patch for a bite line.

36. A method as set forth in claim 15 including the  
15 step of defining an unoccupied seat patch for an ischium.

37. A method as set forth in claim 15 including the step of defining an area for a seat suspension in the seat.

20           38. A method as set forth in claim 15 including the step of defining an unoccupied seat patch for a thigh.

39. A method as set forth in claim 15 including the step of defining a waterfall region of an unoccupied seat.

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40. A method of using a design template to design a vehicle seat comprising:



providing at least one design template having a torso section being one of a group comprising a large male, medium male and small female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture and at least one cross-sectional section cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template;

establishing occupant accommodation criteria based on positioning the at least one design template in a predetermined class of vehicles to define occupied seat position to accommodate each design template on a seat having a seat cushion and a seat back in a vehicle representing the vehicle package criteria; and

defining at least one from a group comprising unloaded patches on the seat at A, S<sup>u</sup>, L<sup>u</sup>, B, I<sub>p</sub><sup>u</sup> and T<sup>u</sup>;

defining at least one from a group comprising a seat back height, seat cushion length, head restraint position, shoulder patch, thorax patch, lumbar patch, bite line patch, ischial patch, thigh patch, seat cushion bolster, and seat suspension for the seat relative to the design template.

41. A method as set forth in claim 40 wherein said step of defining a seat back height for the seat relative to the design template comprises terminating a seat back height relative to the design template at or above a top of the shoulder patch.

42. A method as set forth in claim 40 wherein said  
step of defining a seat back height for the seat relative to  
the design template comprises locating a top cross member of  
the seat back frame relative to the design template at a  
5 position equal to or higher than the thorax patch in the  
unoccupied seat.

43. A method as set forth in claim 40 wherein said  
step of defining a head restraint position for the seat  
10 relative to the design template comprises determining a  
position of a center of mass of a head for the torso section  
relative to the design template, locating a back of a head for  
the torso section of the large male relative to the determined  
position of the center of mass of the head, and defining a  
15 lowest maximum height of the head restraint relative to the  
design template at the back of the head for the torso section  
of the large percentile male having the ERECT posture.

44. A method as set forth in claim 40 wherein said  
20 step of defining a shoulder patch for the seat relative to the  
design template comprises defining an area for the shoulder  
patch relative to the design template between a T4 contact  
zone for the torso section of the large male having the ERECT  
posture and the T4 contact zone for the torso section of the  
25 medium male having the SLUMPED posture.

45. A method as set forth in claim 40 wherein said  
step of defining a thorax patch for the seat relative to the

design template comprises defining an area for the thorax patch relative to the design template between a thorax seat patch for the torso section of the large male having the ERECT posture and the thorax seat patch for the torso section of the  
5 small female having the SLUMPED posture.

46. A method as set forth in claim 40 wherein said step of defining a lumbar patch for the seat relative to the design template comprises defining an area for the lumbar  
10 patch relative to the design template between a lumbar seat patch for the torso section of the large male having the ERECT posture and the lumbar seat patch for the torso section of the small female having the SLUMPED posture.

47. A method as set forth in claim 40 wherein said step of defining a lumbar patch for the seat relative to the design template comprises locating a two-way, horizontal displacement, adjustable lumbar support for the seat relative  
15 to the design template midway between and the highest and lowest locations of L4 for the torso sections of the design  
20 template.

48. A method as set forth in claim 40 wherein said step of defining a lumbar patch for the seat relative to the  
25 design template comprises locating a minimal vertical displacement of an adjustable lumbar support for the seat relative to the design template representing the highest and

lowest locations of L4 for the torso sections of the design template.

49. A method as set forth in claim 40 wherein said  
 5 step of defining a seat suspension for the seat relative to  
 the design template comprises defining an area for the seat  
 suspension relative to the design template between a furthest  
 forward and rearward ischial load points for the torso section  
 of the large male having the SLUMPED posture and for the torso  
 10 section of the small female having the ERECT posture.

50. A method as set forth in claim 40 wherein said  
 step of defining a seat cushion length for the seat relative  
 to the design template comprises terminating a length of the  
 15 seat cushion relative to the design template from  $I_p$  on the  
 torso section of the small female.

51. A seat comprising:  
 a seat cushion;  
 20 a seat back associated with said seat cushion; and  
 at least one from a group comprising a seat back  
 height, seat cushion length, head restraint position, shoulder  
 patch, thorax patch, lumbar patch, bite line patch, ischial  
 patch, thigh patch, and seat suspension being defined for said  
 25 seat cushion and said seat back relative to a design template  
 having a torso section being one of a group comprising a large  
 male, medium male and small female having each being one of a  
 group comprising an ERECT posture, a NEUTRAL posture and a

SLUMPED posture and at least one cross-sectional section cooperating with said torso section at an anatomical landmark to provide a three-dimensional design template.

5           52. A seat as set forth in claim 51 wherein said seat back height of said seat back terminates at or above a top of the shoulder patch on the unloaded seat surface of the seat.

10           53. A seat as set forth in claim 51 wherein said seat back includes a top cross member at a position equal to or higher than the thorax patch in the unoccupied seat.

15           54. A seat as set forth in claim 51 wherein said head restraint position is located relative to a position of a back of a head for the torso section being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture.

20           55. A seat as set forth in claim 51 wherein said two-way, horizontal displacement, lumbar support is located between the highest and lowest locations of L4 for the torso sections of the design template.

25           56. A seat as set forth in claim 55 wherein said lumbar support is located for minimal vertical displacement to be between on the highest and lowest locations of L4 on the lumbar patch of torso sections of the design template.

57. A seat as set forth in claim 51 wherein said seat cushion length terminates at a back of a calf of the torso section for the small female sitting in a position on the seat that accommodates her driving position.

58. A seat as set forth in claim 51 wherein said seat suspension is defined in an area under the ischial patch for the torso section of the large male having the SLUMPED posture and for the torso section of the small female having the ERECT posture.

59. A seat as set forth in claim 51 including a seat anti-submarining restraint system defined in an area between a furthest forward ischial load zone for the torso section of the high clearance offset for the design template and the vertical barrier at the nose of the seat cushion to horizontal motion of the ischium for the design template.